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LEANNE MYNOTT
MANAGER EXAMINATION SUPPORT
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AUSTRALIA
Patents Act 1990
PROVISIONAL SPECIFICATION
FOR A PROVISIONAL PATENT

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Invention Title: **Assembly For Partial Release, Stud Fastener And Manual Override**

The following statement is a description of this invention

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This invention relates to various types of fasteners and fastener assemblies.

In a first aspect, the invention is concerned with an assembly for partial release of an element such as a closure or hatch.

The invention in its first aspect was prompted by a desire to improve on the present system used to test the supply of oxygen masks in passenger aircraft in emergency situations. The invention in its first aspect will be described in this context. However, it is to be understood that the invention is not limited to this application.

Passenger aircraft are designed so that, in an emergency, such as the sudden loss of cabin pressure, oxygen masks connected by tubing to an oxygen supply automatically drop down for use by passengers. The masks are made available above each passenger seat but also in other areas where passengers may be located at the time of the emergency. These include aircraft toilets, lounges and stairs, for example.

It is necessary that this emergency equipment is tested regularly to ensure that it will work in an emergency. Each emergency oxygen mask is stored behind a hatch. Under current practice, when testing is carried out, it is undesirable that the hatch opens fully to release the oxygen mask and connecting tubing. It would be extremely time consuming to have to repack each oxygen mask and tubing into its compartment after full release of the hatch. Consequently, the current practice is to use a test peg to restrict opening of the hatch. The test peg allows the hatch to open to only a small extent, sufficiently to show that the emergency system is operating correctly but insufficiently to allow the mask and tubing to drop out of its cavity.

However, although the current procedure does not involve the need to repack each oxygen mask and tubing in its cavity, the present procedure is still extremely time consuming.

Under the present procedure, an operator must insert a hand tool into an aperture in each hatch and rotate the hand tool to pull down the test peg. This procedure must be carried out in every location in which an oxygen mask is stored behind a hatch. Some of these locations are difficult to access, such as hatches positioned over stairs inside aircraft cabins, for example.

After each test peg has been pulled down, oxygen is delivered to each oxygen mask location. The release of oxygen is intended to trigger the release of the hatch, so that in an emergency situation the oxygen masks would fall down. However, the test peg prevents the hatch from opening fully. The hatch is caught by the peg so that the hatch

opens only to a small degree - approximately 5° - which is sufficient to demonstrate that the particular hatch operates correctly.

After inspecting each of the hatches to ensure that they opened correctly, the operator must then push each hatch shut and once again engage the hand tool to rotate and retract the test peg. The test peg needs to be rotated to the "full release" position so that the hatch can open fully in an emergency.

If in testing the system an operator fails to insert the hand tool to rotate and pull down the test peg prior to testing the efficacy of the emergency equipment, the oxygen mask and tube at that location will be fully released because the hatch will not be prevented from opening to its full extent. This will require the subsequent repacking of the mask and tube. As stated above, this is a time consuming procedure.

It is an object of the present invention in its first aspect to greatly reduce the amount of labour and hence cost of testing emergency oxygen mask release systems. In particular, it is an object of the present invention to provide an assembly which enables the test peg to be lowered without the need for insertion of a hand tool. In some embodiments, it is an object of the present invention to provide an assembly which enables the hatch to be closed and/or the test peg to be raised without the need for manual operation.

Accordingly, in its first aspect, this invention provides an assembly for release of an element, the assembly including a peg moveable between a first position in which the peg restricts release of the element and a second position in which the peg does not restrict release of the element, and means to move the peg from the second position to the first position, the means including material adapted to contract when activated.

In a preferred embodiment, the assembly of the invention includes means to move the peg from the first position to the second position, the means including material adapted to contract when activated.

In a further preferred embodiment, the assembly of the invention includes means to move the element to a closed position.

Preferably, the element is a hatch, flap, door or other closure. The element may close off a compartment or cavity, such as a cavity in which an oxygen mask and tubing is stored. The element is not restricted to this environment.

The peg is preferably the same as or a substitute for the test peg currently used for testing oxygen mask release systems, as described above. The peg may take any suitable form. It is preferred that the peg moves by rotation between the first position

and the second position. Consequently, it is preferred that the peg has one or more arms, projections or other means adapted to engage restricting means when in the first position and to have no such engagement in the second position. An example is given in connection with the drawings, below.

The means to move the peg from the second position to the first position include material adapted to contract when activated. This material is preferably shape memory alloy wire. Shape memory alloys are known and are usually made predominantly or wholly of titanium and nickel. They may also include other material, such as aluminium, zinc and copper. A shape memory alloy is capable of adopting one shape below a predetermined transition temperature and changing to a second shape once its temperature exceeds the transition temperature. Conversely, when the shape memory alloy cools below the transition temperature, it is capable of adopting the first shape again.

Shape memory alloy wire currently available, such as that sold under the trade mark Nitinol, is capable of contracting by about 3 percent when activated by heating.

The Nitinol wire may be provided over a linear path. Alternately, if desired, the Nitinol wire may be provided over a non-linear path. This may have the effect of permitting the assembly of the invention to be provided in a more compact configuration. In a non-linear path, the Nitinol wire preferably loops over one or more spindles or rollers.

Activation of the material adapted to contract when activated is preferably achieved through electrical resistance heating, with a wire feed to the assembly.

As indicated above, in a preferred embodiment the assembly of the invention includes means to move the peg from the first position to the second position. It is preferred that these means also comprise or include shape memory alloy wire. In a particularly preferred embodiment, the peg is rotated between the two positions by two separate shape memory alloy wires. In this embodiment, the first wire is attached to a first position on the peg. When activated, this wire contracts to rotate the peg through, say, 90° in order to move it from the second position to the first position. The second shape memory alloy wire is attached to a second position on the peg. When activated, this wire contracts to rotate the peg in the opposite direction to the first wire, to restore the peg to the second position.

In the embodiment in which the assembly restores the element, such as the hatch, to the original position, the assembly preferably includes a third shape memory alloy wire which contracts when activated. When the peg is in the first position, contraction of the

third shape memory alloy wire may be designed to draw the peg is such a way that interference between the peg and the element, such as the hatch, causes the element to return to its original position. Where the element is a hatch, the original position is preferably "hatch closed".

Preferably the shape memory alloy wire which moves the peg from the second position to the first position travels over a linear path. In the embodiment of the assembly of the invention where there is a second shape memory alloy wire to move the peg between the first position and the second position, preferably this wire also travels over a linear path. In the embodiment in which the assembly includes means to restore the element to the original position, preferably this is shape memory alloy wire which travels over a non-linear path. The purpose of this is to increase the amount of "travel" caused by the shape memory alloy wire when it contracts.

Activation of the shape memory alloy wire can be initiated from a central location, using the wiring system of, for example, the aircraft. It is also within the scope of this invention that the activation is initiated by remote means, such as a hand held tool operating through the use of any suitable form of energy, including microwave, electromagnetic, sonic, infra-red, radio frequency and so on.

A preferred embodiment of the assembly of the invention is described below in connection with the drawings.

In a second aspect, the invention is concerned with a stud fastener. Stud fasteners are useful in many applications. They can be used, for example, to close doors, being attached to a door frame and adapted to receive a stud on a door. A stud fastener can be used in many other applications.

Accordingly, in the second aspect, the invention provides a fastener including:

a stud having a locking cavity;

an aperture adapted to receive the stud;

locking means adapted to engage the locking cavity; and

a shuttle rotatable by rotating means including material adapted to contract when activated, the shuttle being rotatable by the rotating means between a locking position, in which the locking means engages the locking cavity, and an unlocking position in which the locking means does not engage the locking cavity.

The stud may take the form of a pin or peg, with the locking cavity preferably being a groove around all or part of the stud. Preferably, the stud in the region of a locking cavity is of circular cross section, but the invention is not limited to this embodiment.

The aperture adapted to receive the stud is preferably of the same shape as the cross sectional shape of the stud, eg, circular. The aperture may take any other suitable shape.

The locking means adapted to engage the locking cavity is preferably one or more teeth adapted to engage the locking cavity, such as the groove.

The shuttle which is rotatable by the rotating means is rotatable between a locking position in which the locking means such as the teeth engage the locking cavity, such as the groove, and an unlocking position in which the locking means do not engage the locking cavity. The shuttle preferably incorporates means which engages the locking means in the locking position and which fail to engage the locking means or which move the locking means out of engagement with the locking cavity in the unlocking position.

In a particularly preferred embodiment, the shuttle has one or more apertures into which the locking means may be received in the unlocking position. When the locking means, such as teeth, are not in these apertures, the shuttle is designed to push the locking means into the locking cavity and hence to the locking position.

In another embodiment, the shuttle may include or be associated with means adapted to engage the locking means and draw them out of engagement with the locking cavity, when the shuttle is rotated to the unlocking position.

The shuttle is rotatable by rotating means which includes material adapted to contract when activated. Preferably, this material is shape memory alloy wire, as discussed above in connection with the first aspect of the invention. It is further preferred that the shape memory alloy wire is wound around the shuttle which is rotatable within a body for the fastener. The shape memory alloy wire is attached at one end to the shuttle and at the other to a non-rotatable part of the fastener. When the shape memory alloy wire is caused to contract by the application of suitable energy to reach the necessary temperature, the shuttle can rotate from the locking position to the unlocking position. A second shape memory alloy wire may be similarly connected to the shuttle in order to rotate it from the unlocking position to the locking position.

The fastener of the second aspect of the invention may include lock status sensors, which can report whether the fastener is in the locked or unlocked state. Such sensors

may act as a reed switch, for example, so that when they make contact a report is generated that the fastener is in the locked or unlocked state, depending on the construction of the fastener. The lock status sensors may also work by enabling completion of an electrical circuit. Other configurations and means of sensing may also be applicable.

One embodiment of the fastener according to the second aspect of the invention is described below in connection with the drawings and this is an especially preferred embodiment. A second embodiment is described in connection with international patent application number PCT/AU2004/000623, the contents of which are imported herein by reference.

The fastener of the second aspect of the invention also preferably includes bias means, such as a spring, biasing the fastener towards the locked state. The fastener of the invention also preferably includes an ejector spring, to assist ejection of the stud when the locking means is no longer engaged with the locking cavity.

The fastener of the invention may also include a temperature sensor for sensing the temperature of the shape memory alloy wire in the preferred embodiments. This can adjust the amount of energy applied to the shape memory alloy wire, depending on sensed temperature, to take into account varying conditions. For example, if the temperature is relatively low, a larger amount of power may need to be delivered to the shape memory alloy wire to heat it to the desired temperature. Conversely, if the temperature is high, the amount of power to be delivered to the shape memory alloy wire in order to cause it to contract may be far less. A temperature sensor can enable feedback and cause adjustment of power delivery in this regard.

Optionally, the fastener of the second aspect of the invention has manual override so that the fastener can be released even if the shuttle cannot rotate to the unlocking position. A manual override may be necessary, for example, if there is no power to activate the shape memory alloy wire, or if the fastener fails for some reason. It is the manual override which forms the third aspect of this invention.

Accordingly, the invention in the third aspect provides a manual override for the fastener of a second aspect of the invention or for any other suitable fastener having a shuttle rotatable between a locking position and a unlocking position, the override including a manual actuator adapted to cause the shuttle to move from the locking position to the unlocking position; and

means for drawing the manual actuator so that the shuttle moves to the unlocking position.

Preferably, the means for drawing the manual actuator so that the shuttle moves to the unlocking position comprises or includes a rod connected to the manual actuator. For example, the rod may include a protrusion pivotally connected to the manual actuator. When the rod is pulled in a chosen direction, the manual actuator may be caused to move through its connection via the protrusion on the rod to a position where the shuttle moves to the unlocking position. Preferably, the manual actuator is connected mechanically to the shuttle for this purpose.

For security, it is preferred that the drawing means is biased away from the unlocking position. For example, when the drawing means includes a rod, the rod may need to be pulled against a spring. To further protect against accidental or inadvertent release, the drawing means may include means for engagement with retaining means. The purpose of this is to ensure that the drawing means must deliberately be disengaged from the retaining means before the manual override can be operated. Both of these safety mechanisms can help to ensure that accidental manual release does not occur though vibration, for example.

The drawing means may take any other suitable form, including that of a Bowden cable.

There may be several fasteners which need to be released through manual override. Consequently, the manual override of this third aspect of the invention can be adapted to manually release more than one fastener at the same time. Preferably, this is achieved by linking the manual actuator for the first fastener with a manual actuator for the second fastener and, optionally, with third and subsequent fasteners. The linkage preferably takes place using a connecting rod.

In a fourth aspect, this invention provides a first fastener connected to a second fastener by a linkage, the first and second fasteners being adapted to release by the involvement of means adapted to contract when actuated, the linkage adapted to cause the first and second fasteners to move to an unlocking position by any of the following:

(a) activation of the means adapted to contract when activated in the first fastener;

(b) activation of the means adapted to contract when activated in the second fastener;

(c) activation of the means adapted to contract when activated in both the first and second fasteners; and

(d) manipulation of a manual override.

It is to be appreciated that more than two fasteners may be released according to this fourth aspect of the invention. Preferably, a single fastener in the two or more linked fasteners is sufficiently strong to enable the linkage to release all the linked fasteners in the case of failure of any of the linked fasteners. If there is no power to operate any of the linked fasteners in the normal manner, then all can be released by using the manual override.

The invention will now be described in connection with certain non-limiting examples thereof in connection with the accompanying drawings, in which:

Figure 1 shows, in connection with the first aspect of the invention, a prior art accessing of an oxygen mask hatch together with an operator performing remote testing in accordance with the first aspect of the invention;

Figure 2 shows a simplified view of the hatch and cavity for an oxygen mask, the oxygen mask and tubing being omitted for simplicity;

Figure 3 shows a plan view of the hatch of Figure 2 incorporating the assembly of the first aspect of the invention;

Figure 4 is a sectional view taken along the lines A-A of Figure 3;

Figure 5 is a sectional view taken along the lines B-B of Figure 3;

Figure 6 shows part of the assembly of Figure 3 in the normal (in flight) position;

Figure 7 shows the assembly of Figure 6 after rotation of the peg;

Figure 8 shows the assembly of Figure 6 after delivery of oxygen has caused the hatch to drop;

Figure 9 shows the assembly of Figure 6 after the hatch has been closed by the assembly of the invention;

Figure 10 shows resetting of the hatch closing mechanism;

Figure 11 shows the assembly of Figure 6 after the peg has been rotated to the original position;

Figure 12 is a perspective view of an embodiment of the stud fastener of the second aspect of the invention;

Figure 13 is a bottom end view of the embodiment of Figure 12 with the rear cap removed;

Figure 14 shows the embodiment of Figure 12 with the peg removed, in the locked state;

Figure 15 shows the embodiment of Figure 12 with the peg removed, in the unlocked state;

Figure 16 is a bottom end view of the embodiment of Figure 12, in the locked position;

Figure 17 is a sectional view of the fastener of Figure 16, taken along the lines 17-17 in Figure 16;

Figure 18 is a bottom end view of the embodiment of Figure 12, in the unlocked position;

Figure 19 is a sectional view of the fastener of Figure 16, taken along the lines 19-19 in Figure 18 in the unlocked position;

Figure 20 is a plan view of a manual override of the third aspect of the invention;

Figure 21 is a sectional side elevation of the override of Figure 20, taken along the lines 20-20;

Figure 22 shows the manual override of Figure 20 in the unlocked position;

Figure 23 is a side sectional view taken along the lines 23-23 of Figure 22;

Figure 24 is a perspective view of linked fasteners according to the fourth aspect of the invention;

Figure 25 is an enlargement of one of the fasteners of Figure 24; and

Figure 26 is yet a further enlargement of the fastener of Figure 25 with cover removed.

Turning first to Figure 1, this shows a series of elements, being hatches 6, 8 and 10 installed in the ceiling 12 of an aircraft. Hatch 8 is difficult to access, being located

above stairs 14. Operator 16 is shown using a remote tool 18 to activate assembly 20 (refer Figure 5).

Figure 2 shows in more detail cavity 22 which would normally hold an oxygen mask and tubing (omitted for clarity). Cavity 22 is closed by hatch 8.

As shown in Figures 3 and 4, cavity 22 includes oxygen mask or masks and tubing, shown generally at 24 and oxygen supply and release mechanism shown generally at 26. Assembly 20 includes peg 28 having protrusions 30. Peg 28 is connected to two shape memory allow wires 32 and 34. Shape memory alloy wire 32 is attached to peg 28 at point 36 (refer Figure 6) and when contracted will rotate peg 28 through 90 degrees from the position shown in Figure 6 to that in Figure 7. Shape memory allow wire 34 is connected to peg 28 at attachment point 38 (Figure 10) and when contracted will rotate peg 28 to the position shown in Figure 11, which is the same as that in Figure 6.

Peg 28 is shown inserted in cylinder 40. When peg 28 is in the second position shown in Figure 6, protrusions 30 can fit through aperture 42 of cylinder 40 and hatch 8 can open fully. When peg 28 has been rotated through 90 degrees as shown in Figure 7, protrusions 30 will protrude over part of platform 44 and protrusions 30 will no longer fit through aperture 42. Thus there will be engagement between peg 28 and cylinder 40 as shown in Figures 8 and 9. In Figure 8, peg 28 prevents hatch 8 from opening fully because hatch 8 is engaged by foot 46 on peg 28 while peg 28 is in turn retained within cylinder 40 by engagement of protrusions 30 on platform 44.

When peg 28 rotates as shown in Figure 7, it lowers as shown. When oxygen is delivered via mechanism 26, hatch 8 drops as shown in Figure 8. However, hatch 8 cannot open fully because of the engagement of protrusions 30 with platform 44.

Cylinder 40 is attached to a third shape memory alloy wire 48 via bar 50 movable within slots 52 of cylinder 40. Shape memory alloy wire 48, when activated to contract, draws cylinder 40 upwardly as shown in Figure 9, in order to close hatch 8 through engagement with peg 28. When shape memory alloy wire 48 is no longer activated, cylinder 40 is lowered as shown in Figure 10. Shape memory alloy wire 34 is then activated to contract, as shown in Figure 11 in order to rotate peg 28 through 90 degrees from the position shown in Figure 10 to that shown in Figure 11. Assembly 20 is then in the position in which peg 28 can pass freely through aperture 42 and hatch 8 can open fully to the position shown in Figure 2.

Reference is now made to the embodiment of the second aspect of the invention in Figures 12 to 19. Fastener 60 includes stud 54 having a locking cavity being

circumferential groove 56 (refer Figures 17 and 19). Fastener 60 includes aperture 58 into which stud 54 can be received by a push-fit.

Fastener 60 includes eight teeth 62, each having a tongue 64 which can engage groove 56.

Shuttle 66 is mounted for rotation within body 68 between two positions. The first position is that shown in Figure 14 where locking means 70 maintain teeth 62 in the locking position into aperture 58 (and groove 56 of stud 54 when stud 54 is in aperture 58). The second position is that shown in Figure 15, in which shuttle 66 has rotated sufficiently so that teeth 62 are located in apertures 72 between locking means 70. In this configuration, teeth 62 are no longer maintained in the locked position in aperture 58 (and groove 56 in stud 58 when present).

Shuttle 66 is rotated from one position to the other through shape memory alloy wire 74 and 76, one being used to rotate shuttle 66 to the locking position and the other to rotate it to the unlocking position.

As shown in Figure 12, fastener 60 includes rear cap 78. Power is supplied via electrical wires 80.

In Figure 13, in which rear cap 78 has been removed, shape memory alloy wire 74 can be seen. Also shown is shuttle position sensor 82. This senses whether shuttle 66 is in the locking or unlocking position and can report to an external source (not shown).

Figure 13 also shows wire temperature sensor 84. This senses the temperature of shape memory alloy wire 74 and 76 and can enable the calculation of the amount of power to be delivered to raise wire 74 or 76 to the desired temperature at which it contracts. Temperature sensor 84 can prevent overheating of wires 74 and 76 and can also minimise the amount of electrical energy required to be delivered to wires 74 and 76.

As best shown in Figures 17 and 19, fastener 60 includes in this embodiment sliding plug 86. In the locked position (Figure 17), sliding plug 86 is in contact with stud detector switch 88, because stud 54 has pushed sliding plug 86 down into contact with stud detector switch 88. This enables fastener 60 to report on whether stud 54 is engaged.

Also shown in Figures 17 and 19 are bias spring 90 and ejector spring 92. Bias spring 90 biases fastener 60 to the locking position. Ejector spring 92 facilitates ejection of stud 54 when teeth 62 are no longer engaged in groove 56, as shown in Figure 19.

Shape memory alloy wires 74 and 76 are attached via crimps 94 and 95 as shown in Figures 17 and 19. Shuttle detector switch 97 detects whether shuttle 66 is in the locked or unlocked position.

Figure 16 shows rear cap 78 with manual release 96. This can be operated, for example by hand, to manually rotate shuttle 66 from the locking to the unlocking position, as shown in Figure 18.

Referring now to Figures 20 to 23, these show a fastener 60a similar to fastener 60 in conjunction with a manual override being the third aspect of the invention. Another suitable fastener could be substituted for fastener 60a. Manual override 100 has manual actuator 98 and drawing means being rod 102. Manual actuator 100 is joined to fastener 60a and to rod 102 via protrusion 104 which engages manual actuator 98 through slot 106.

Rod 102 is attached to knob 108 which has engagement ledge 110. Engagement ledge 110 is shown in Figure 20 in engagement with catch 112. Spring 114 biases towards the locking position.

In order to operate manual override 100, knob 108 must be rotated by hand until ledge 110 is no longer in engagement with catch 112. Knob 108 is then drawn upwardly (Figure 20) against the bias of spring 114, to rotate manual actuator 98 upwardly, through engagement of protrusion 104 in slot 106. Thus shuttle 66 is rotated from the locking position shown in Figure 21 to the unlocking position shown in Figure 23, manual actuator 98 being in the position shown in Figure 22. At this stage, stud 54 is ejected as shown in Figure 23 because of ejector spring 92.

Also shown in Figure 20 is actuator linkage 116. This links rod 102 with a second fastener 60b, travelling through conduit 118, as shown in Figure 24. As shown by the detail in Figures 25 and 26, when knob 108 is rotated free of catch 112 and drawn upwardly against the bias of spring 114, actuator linkage 116 ensures that both fasteners 60a and 60b are manually released.

As can be seen in more detail in Figures 25 and 26, in this embodiment fastener 60a is situated under cover 120 and partly within mechanism casing 122, mounted on bracket 124.

It will be apparent to one skilled in the art that variations may be made to the inventions described herein without departing from the spirit or scope of those inventions.

Dated this 20th day of September 2004.

Telezygology Inc.

by its Patent Attorneys
Chysiliou Law

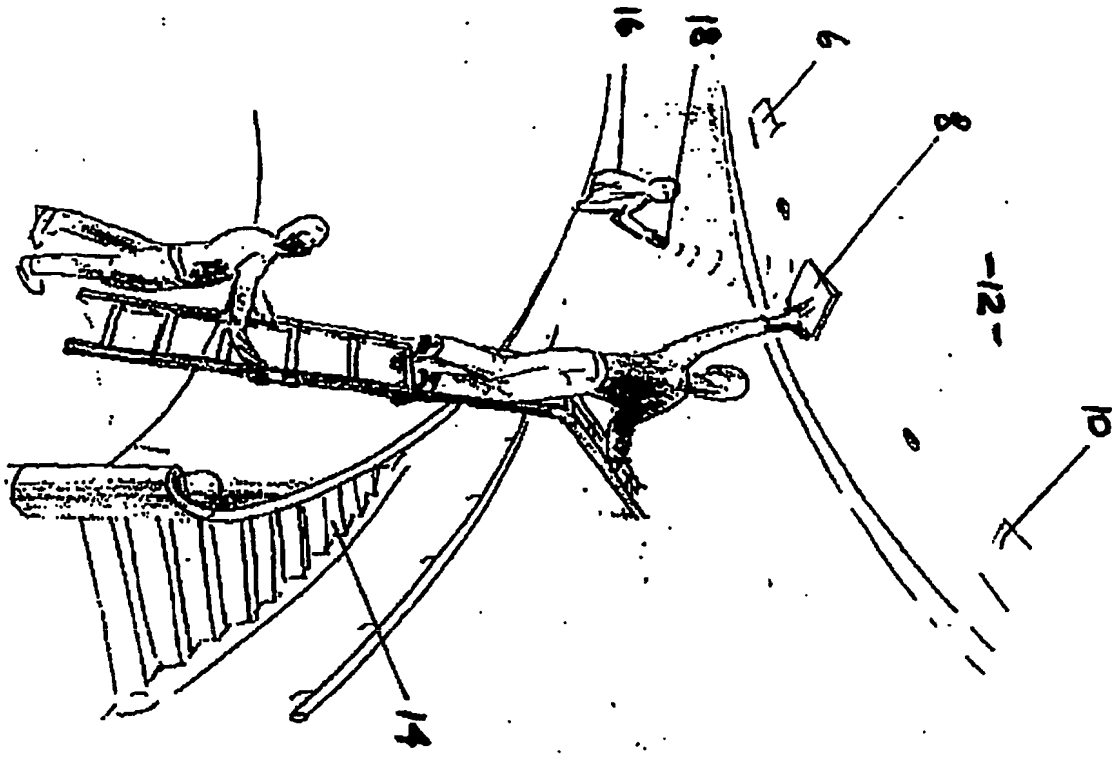


Figure 1

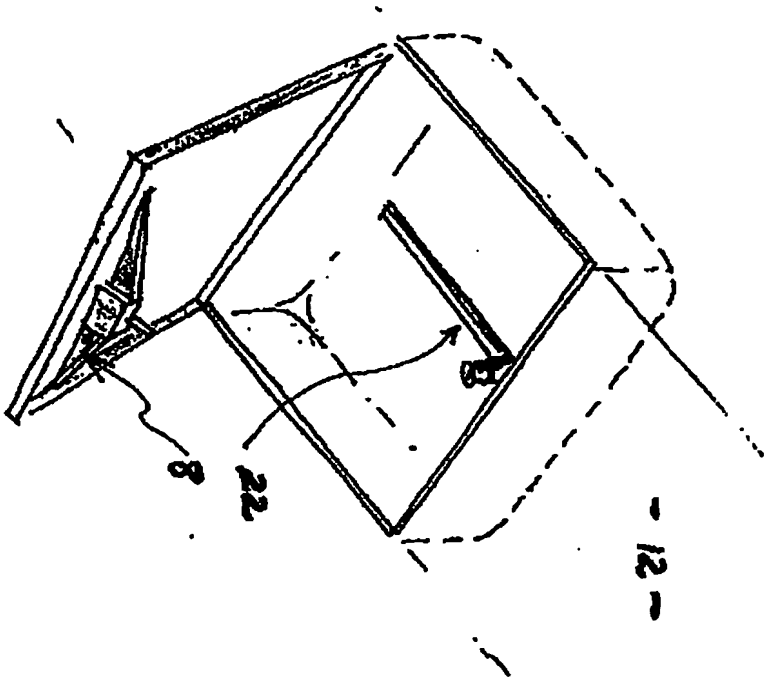


Figure 2

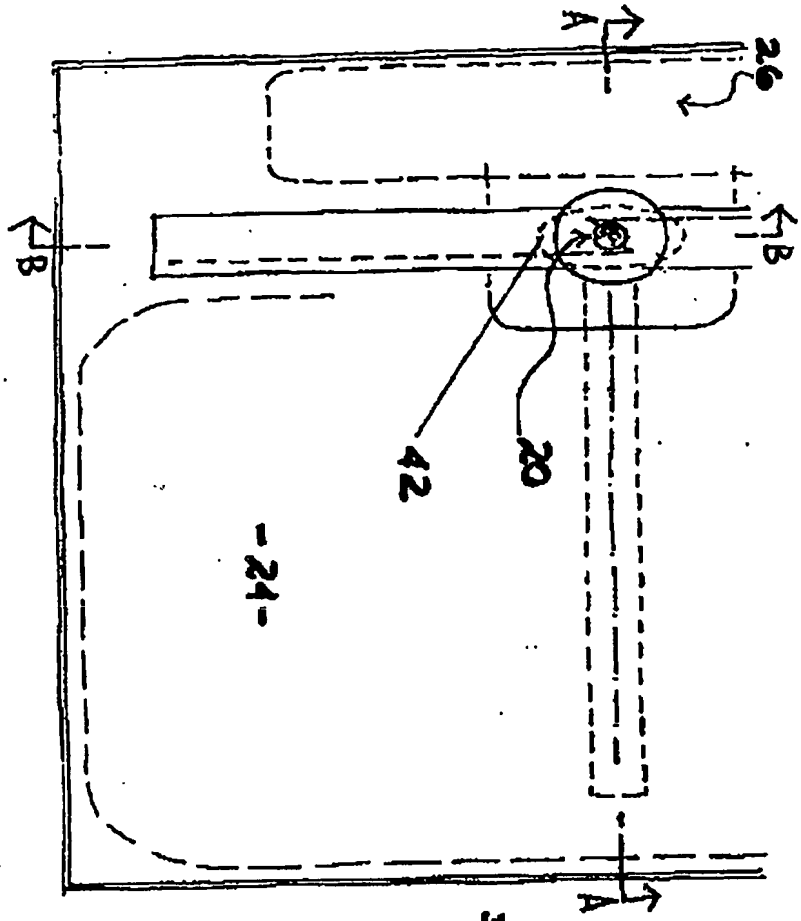


Figure 3

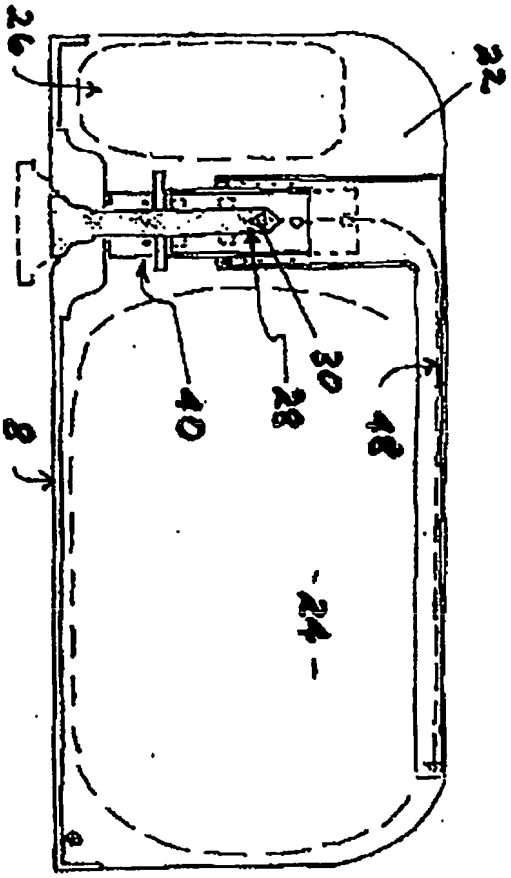


Figure 4

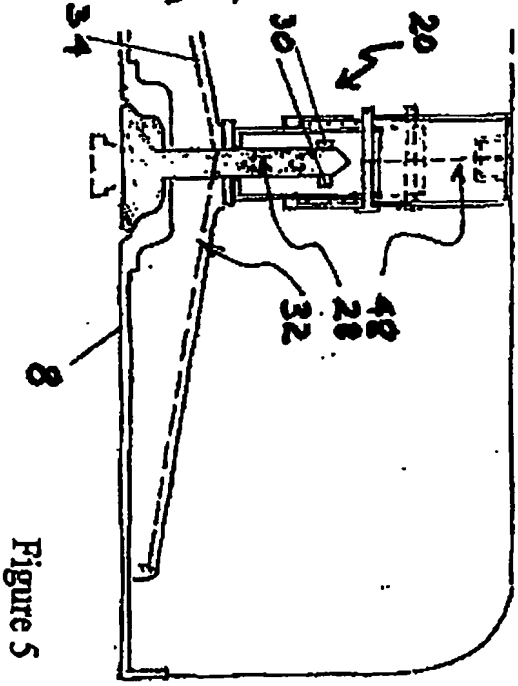


Figure 5

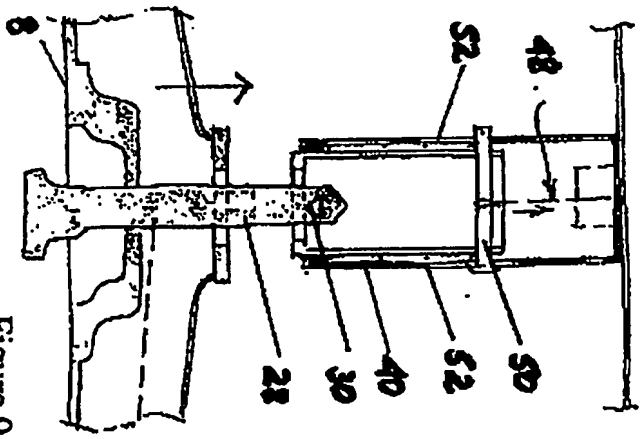


Figure 9

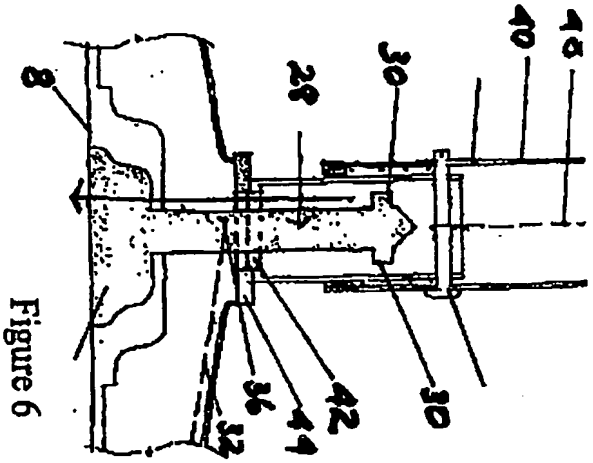


Figure 6

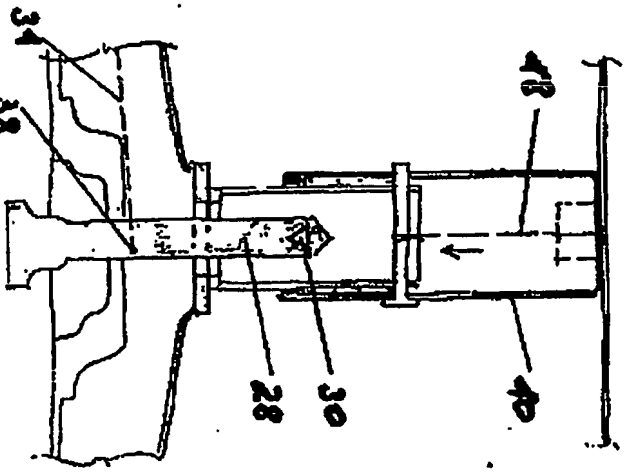


Figure 10

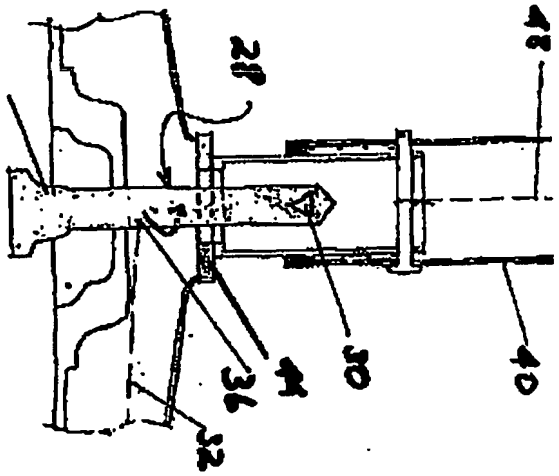


Figure 7

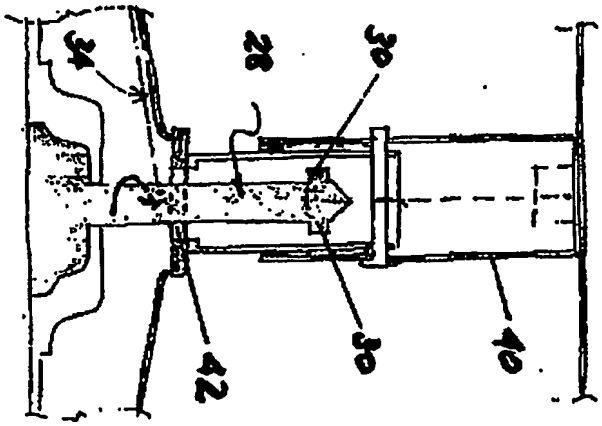


Figure 11

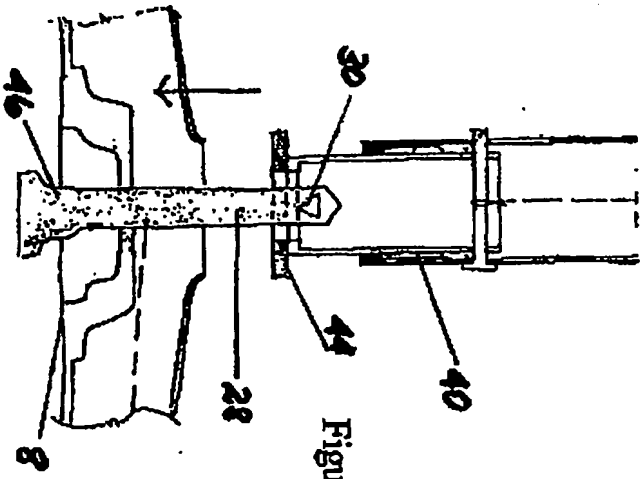


Figure 8

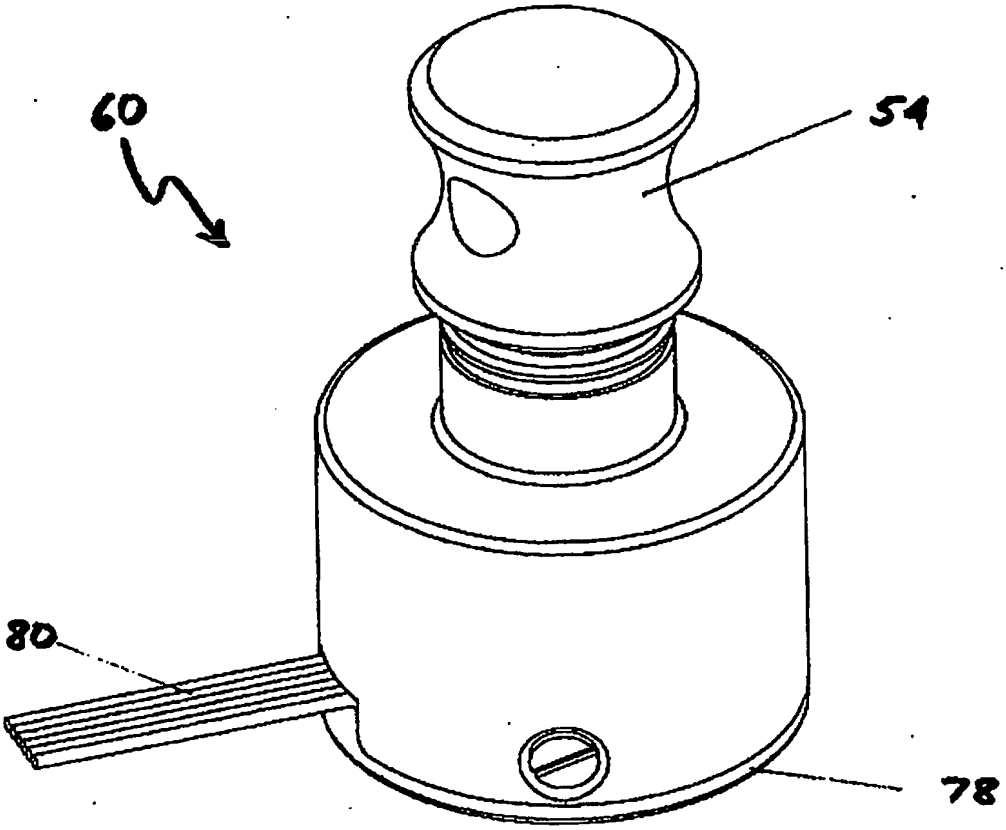


Figure 12

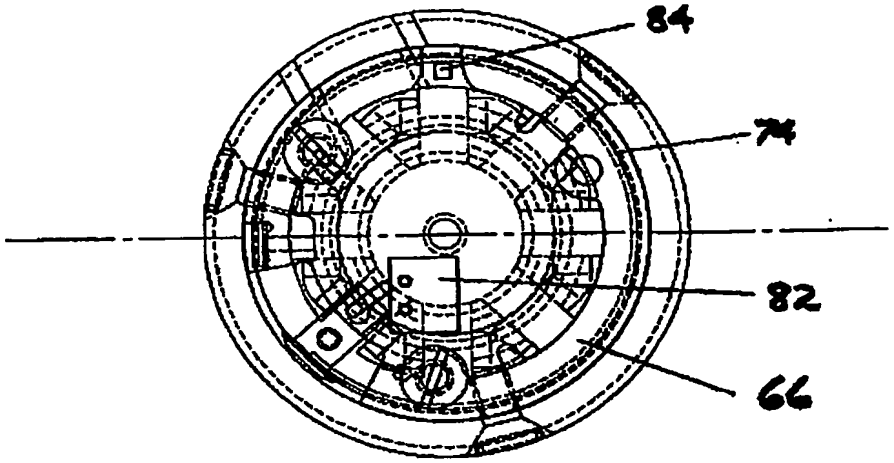


Figure 13

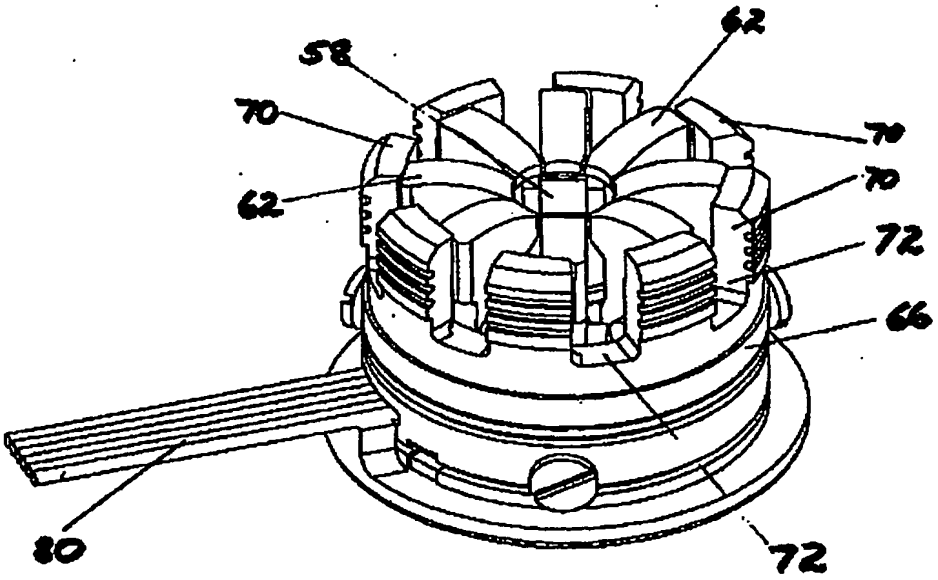


Figure 14

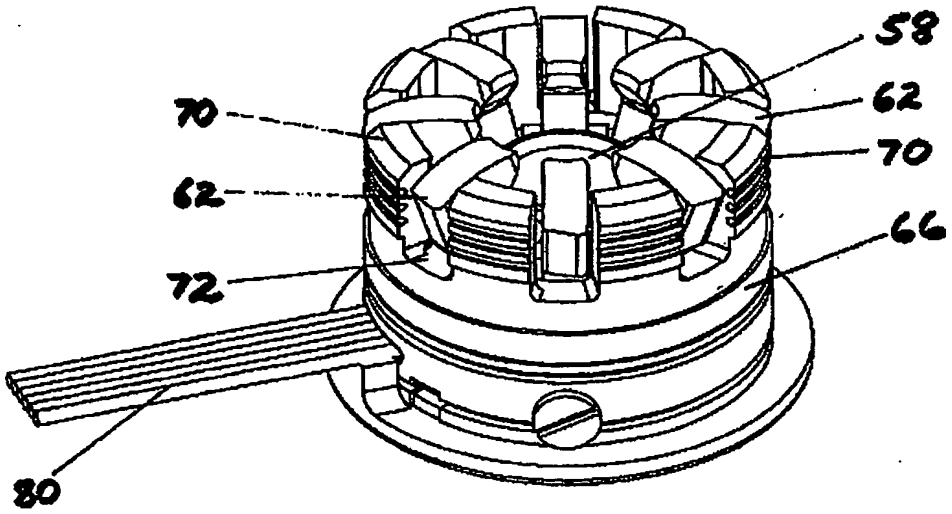


Figure 15

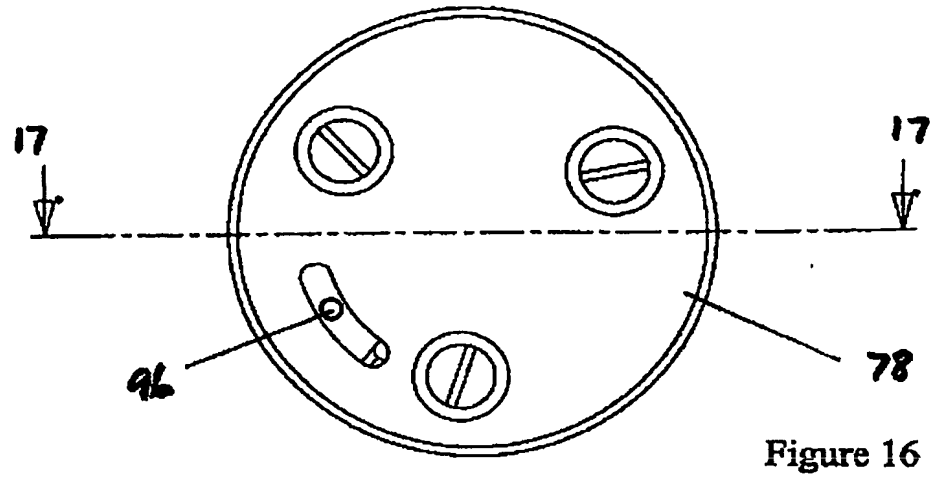


Figure 16

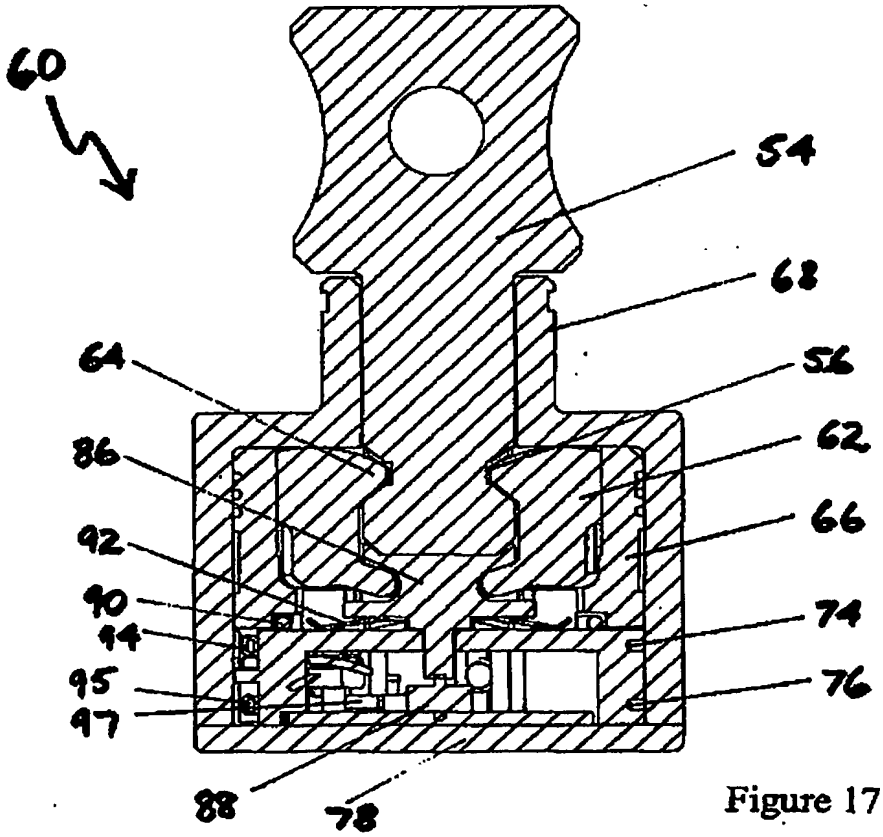


Figure 17

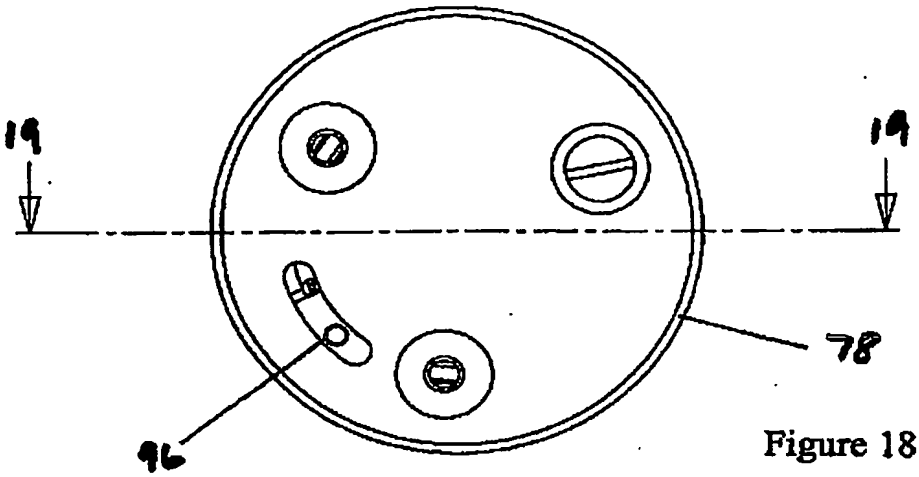
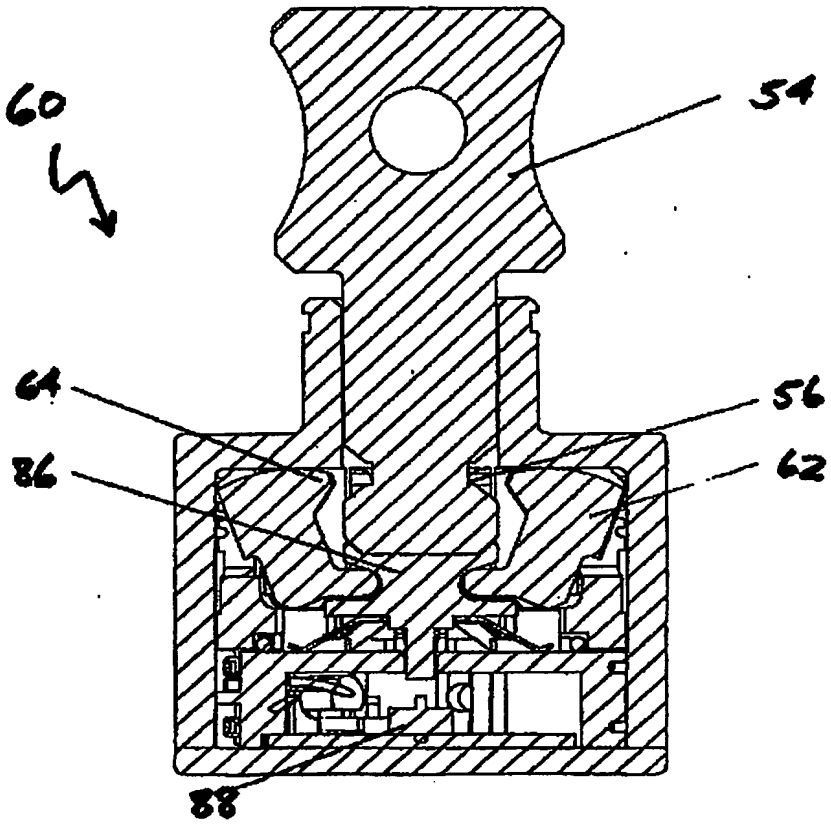


Figure 18



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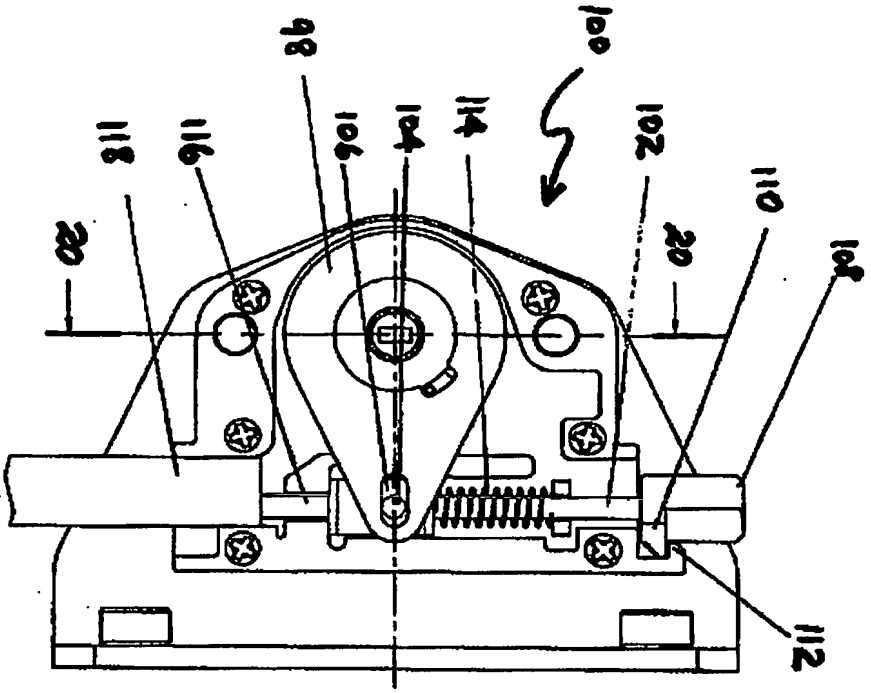


Figure 20

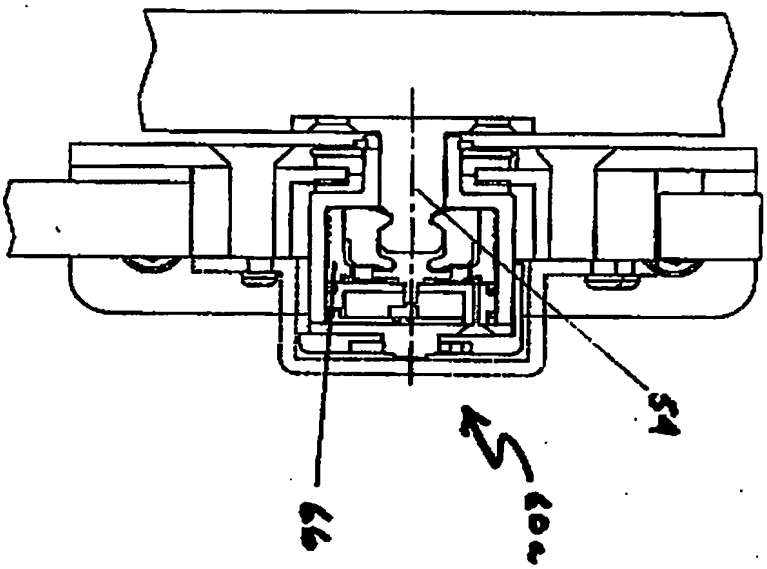


Figure 21

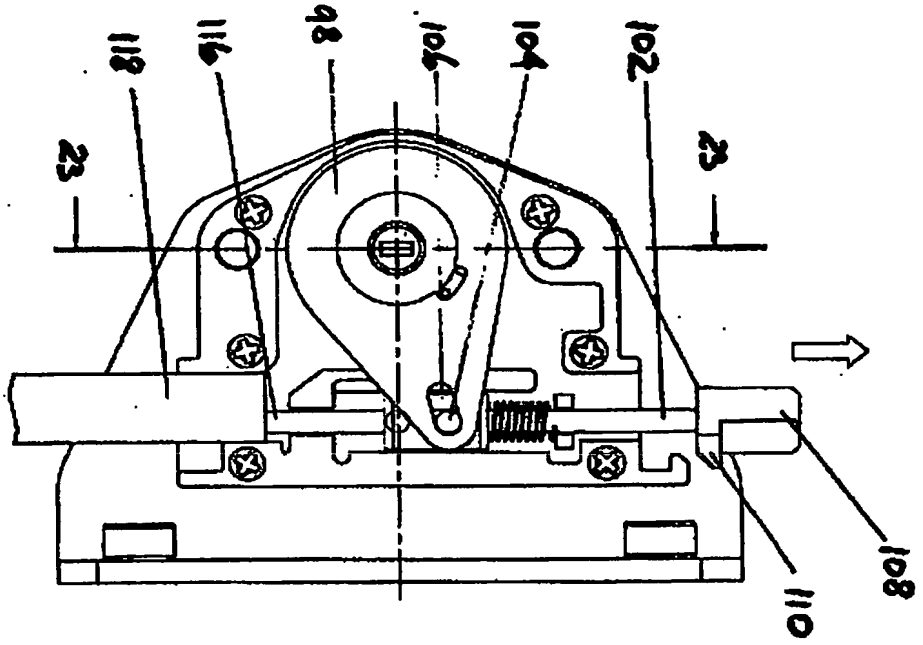


Figure 22

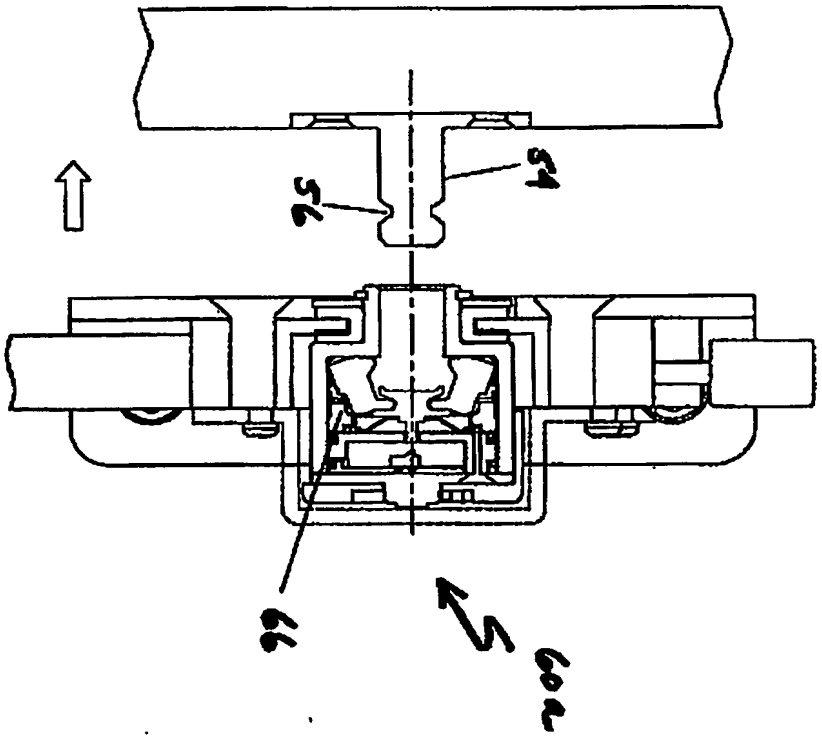
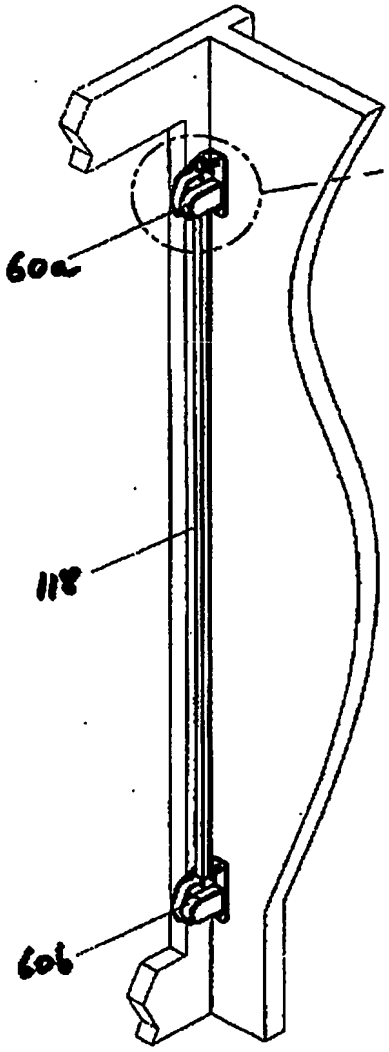
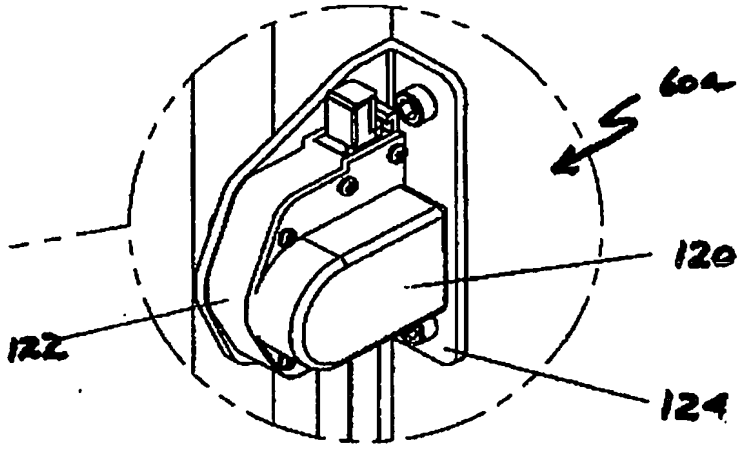


Figure 23

Figure 25





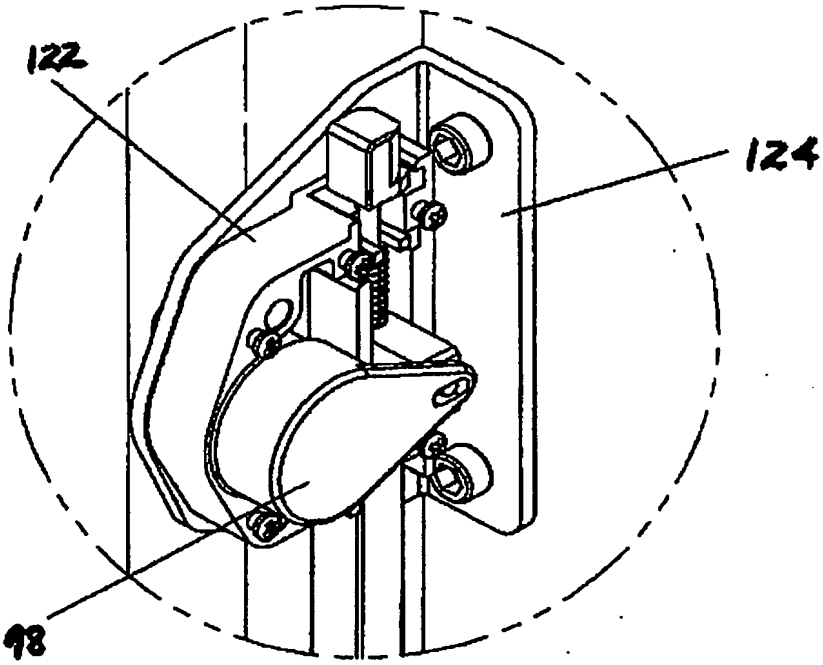


Figure 24

Figure 26

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